Geogenic arsenic mobilization to groundwater

Impact on drinking water production

Van Dooren, Teun[1]
Hartog, Niels[1,2], Van Sijl, Jelle[3], Van den Berg, Hugo[3]

[1] KWR Watercycle Research Institute, Nieuwegein, The Netherlands
[2] Utrecht University, Utrecht, The Netherlands
[3] Brabant Water, 's-Hertogenbosch, The Netherlands

Session 2b - 257
Diffuse pollution of groundwater from geogenic to anthropogenic origins
10-9-2019

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Drinking water production in the Netherlands

Drinking water production: Brabant Water

~185 Mm³ for 2.5 million inhabitants

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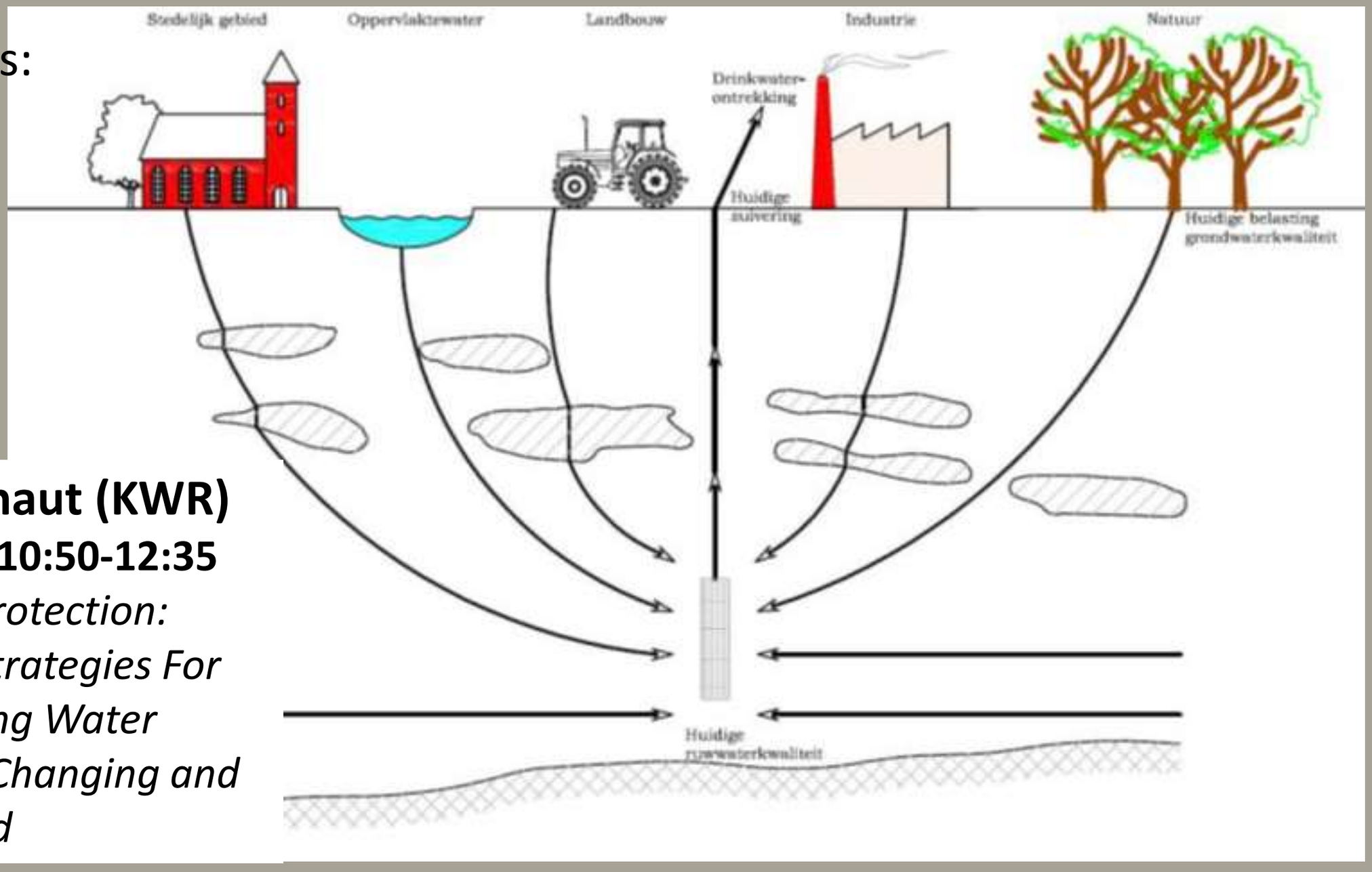
Tilburg well field

Shallow wells:
~60 meters

Deep wells:
~120 meters



Van Loon, Arnaut (KWR)
Session 6: Tue 10:50-12:35
Groundwater Protection: Concepts and Strategies For Securing Drinking Water Resources In A Changing and Uncertain World

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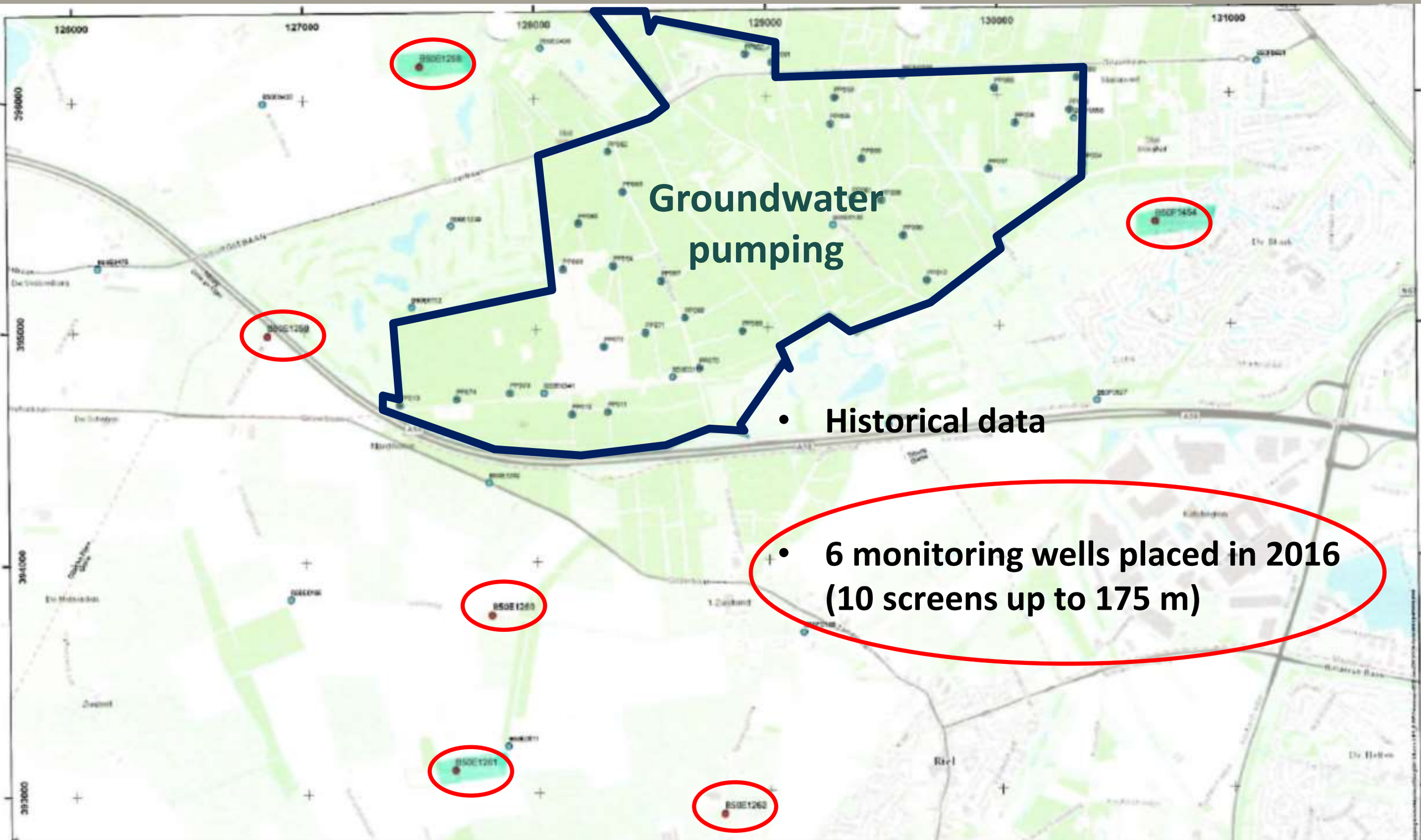

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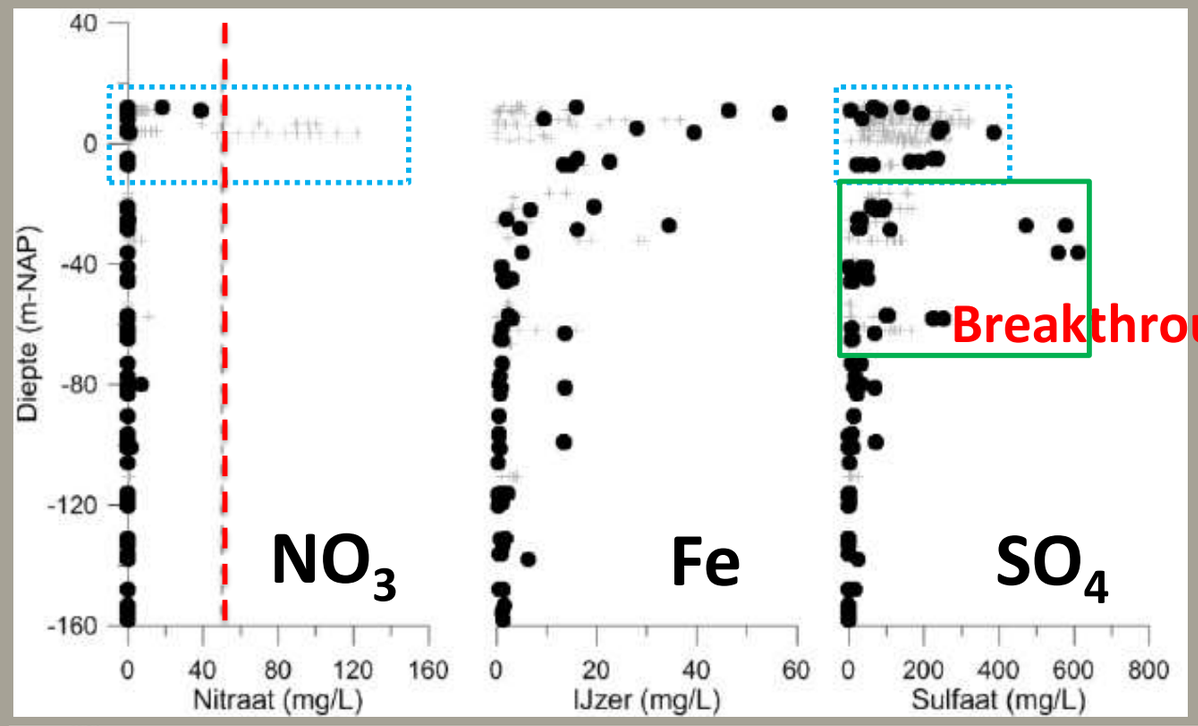
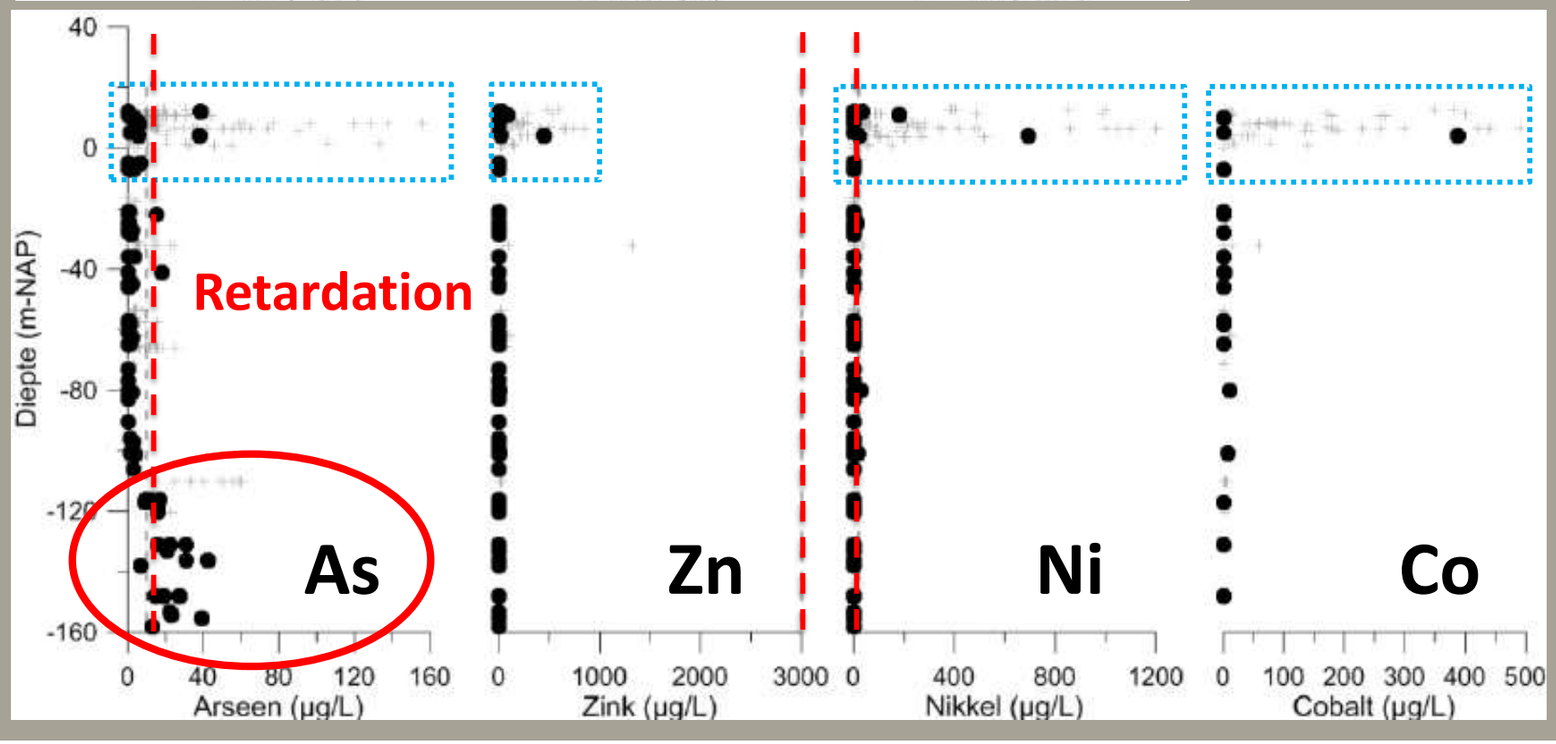
Groundwater quality



+ Historical data
• 2016-2017
— Drinking water limit

Shallow pyrite oxidation by denitrification



$$5FeS_2 + 15NO_3^- + 10H_2O \rightarrow$$

$$\frac{15}{2}N_2 + 10SO_4^{2-} + 5Fe(OH)_3 + 5H^+$$

As ~40 µg/L

WHO-limit: **1 – 10 µg/L**

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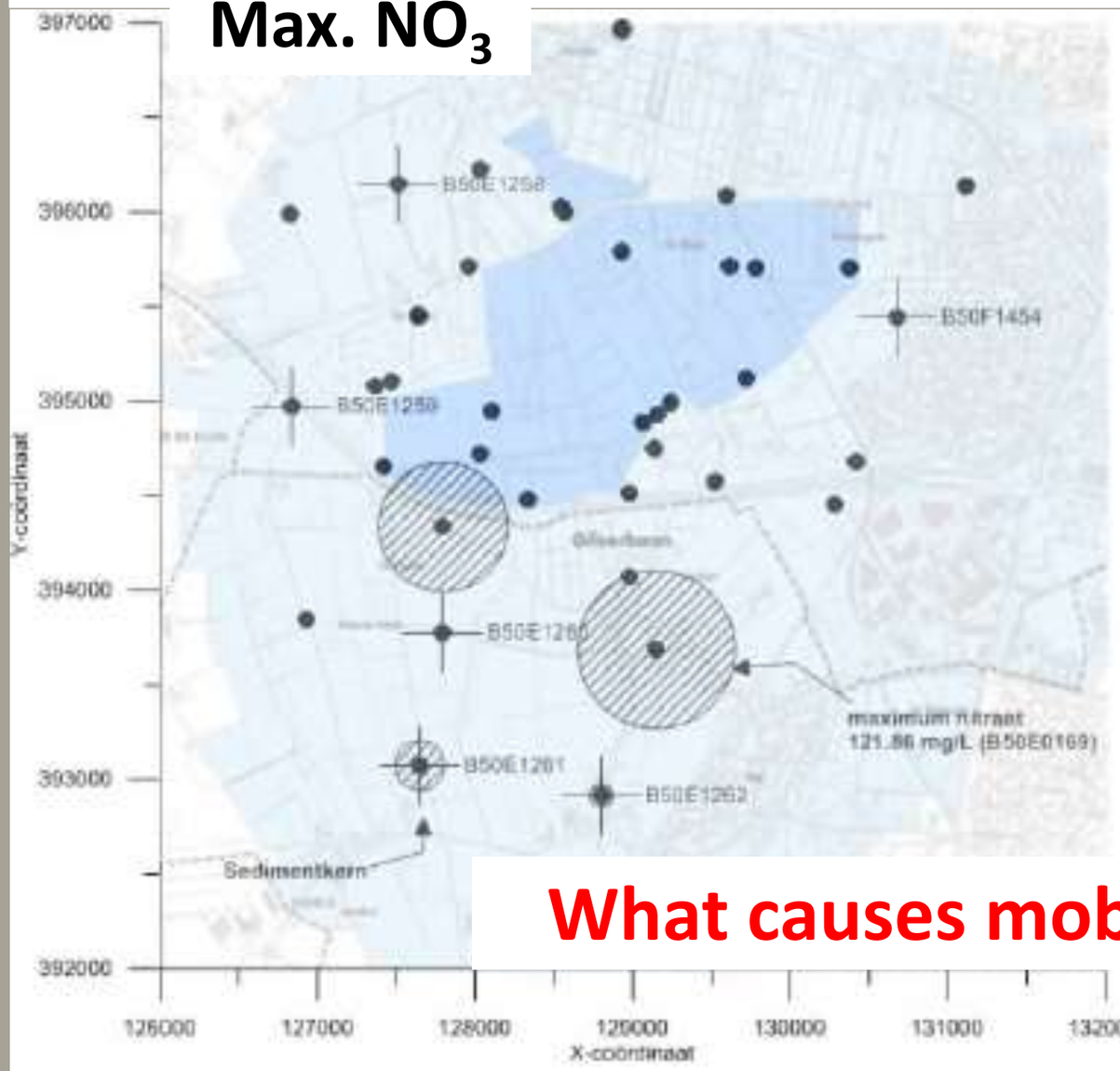
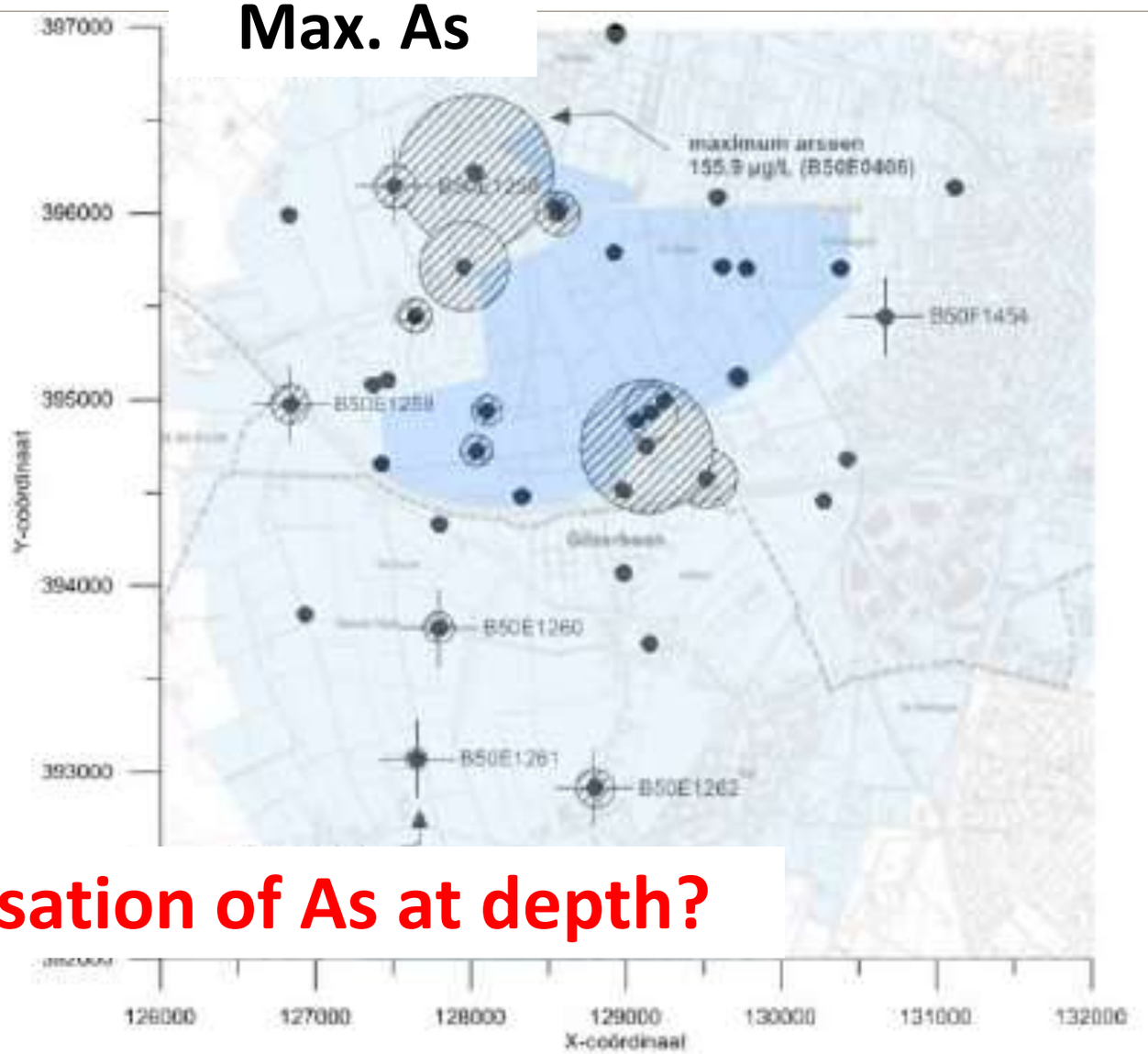
No spatial correspondence NO_3 & As

Max. NO_3



Max. As



What causes mobilisation of As at depth?

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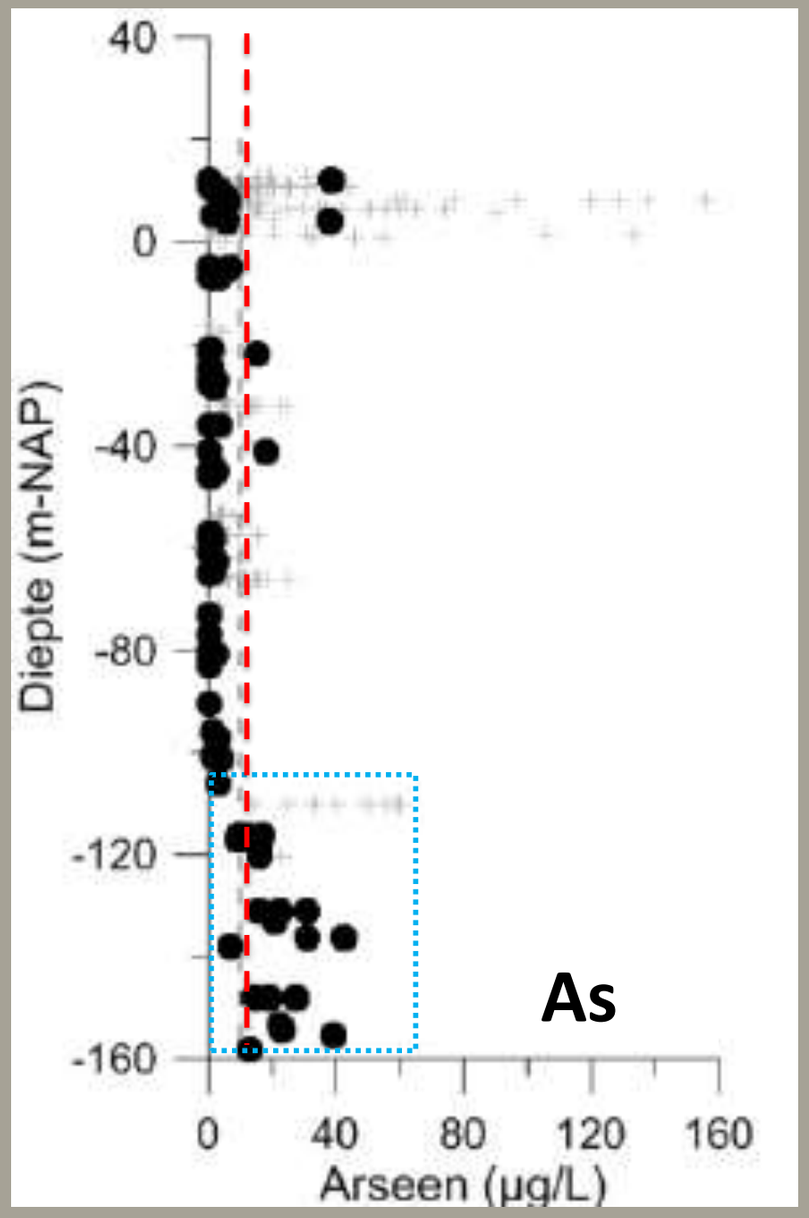
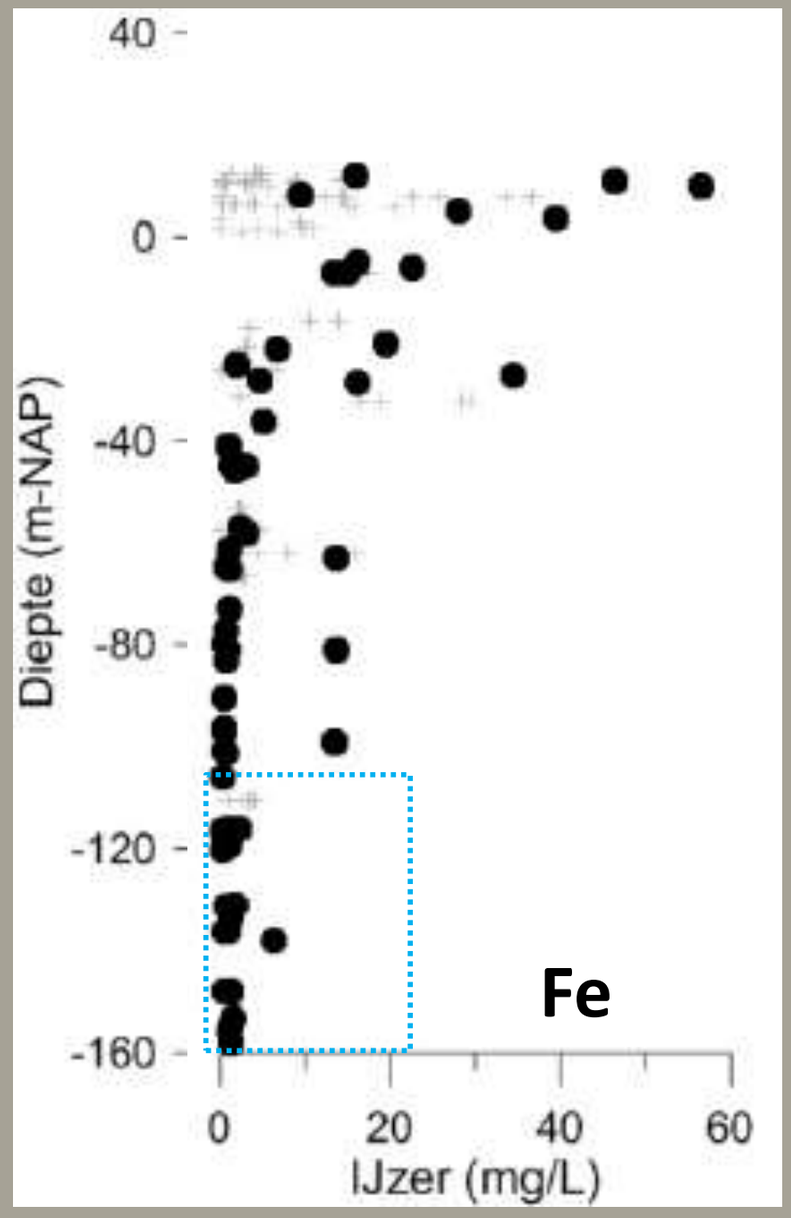
As and Fe in deep groundwater





+ Historical data
• 2016-2017
– Drinking water limit

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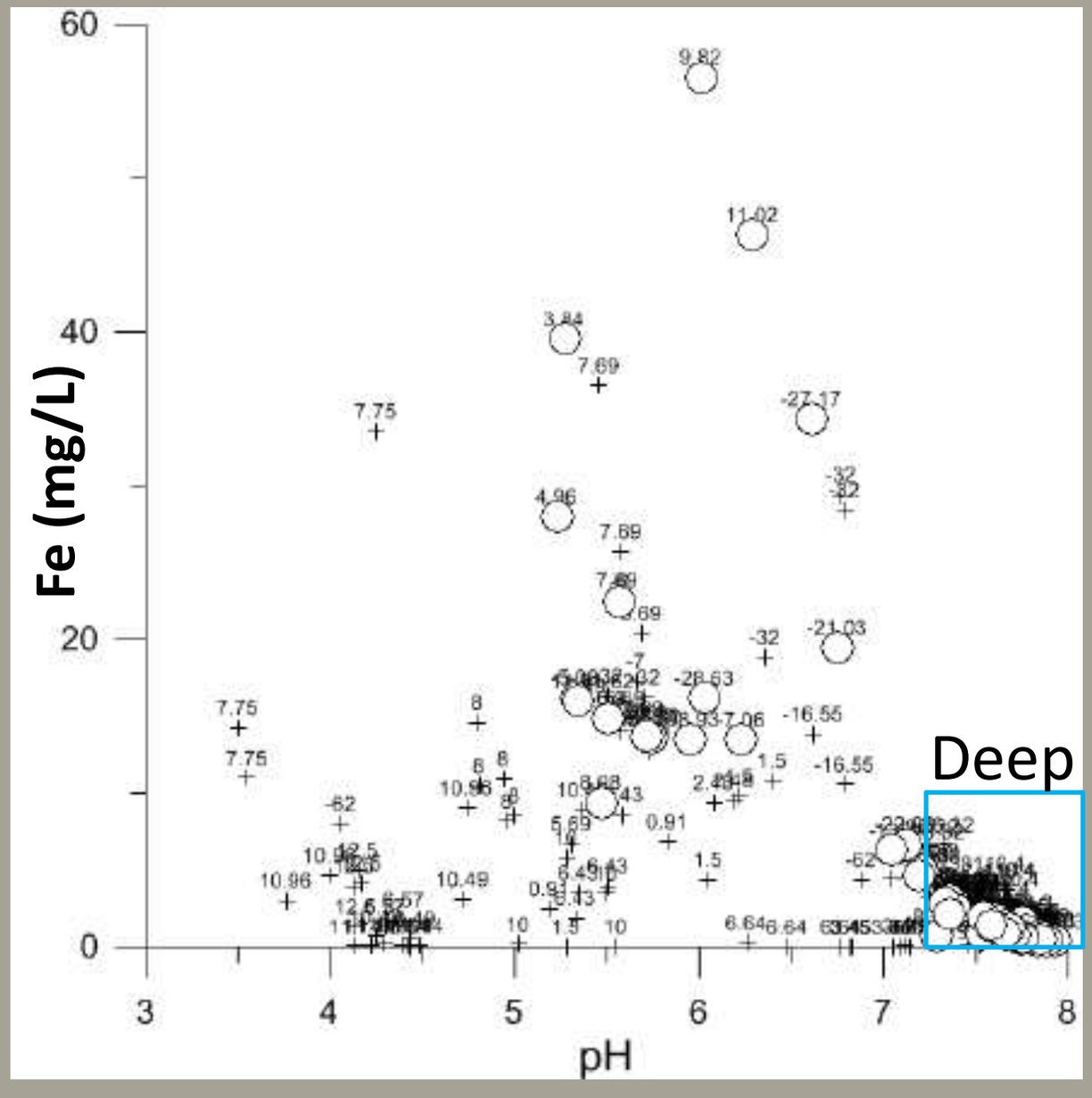
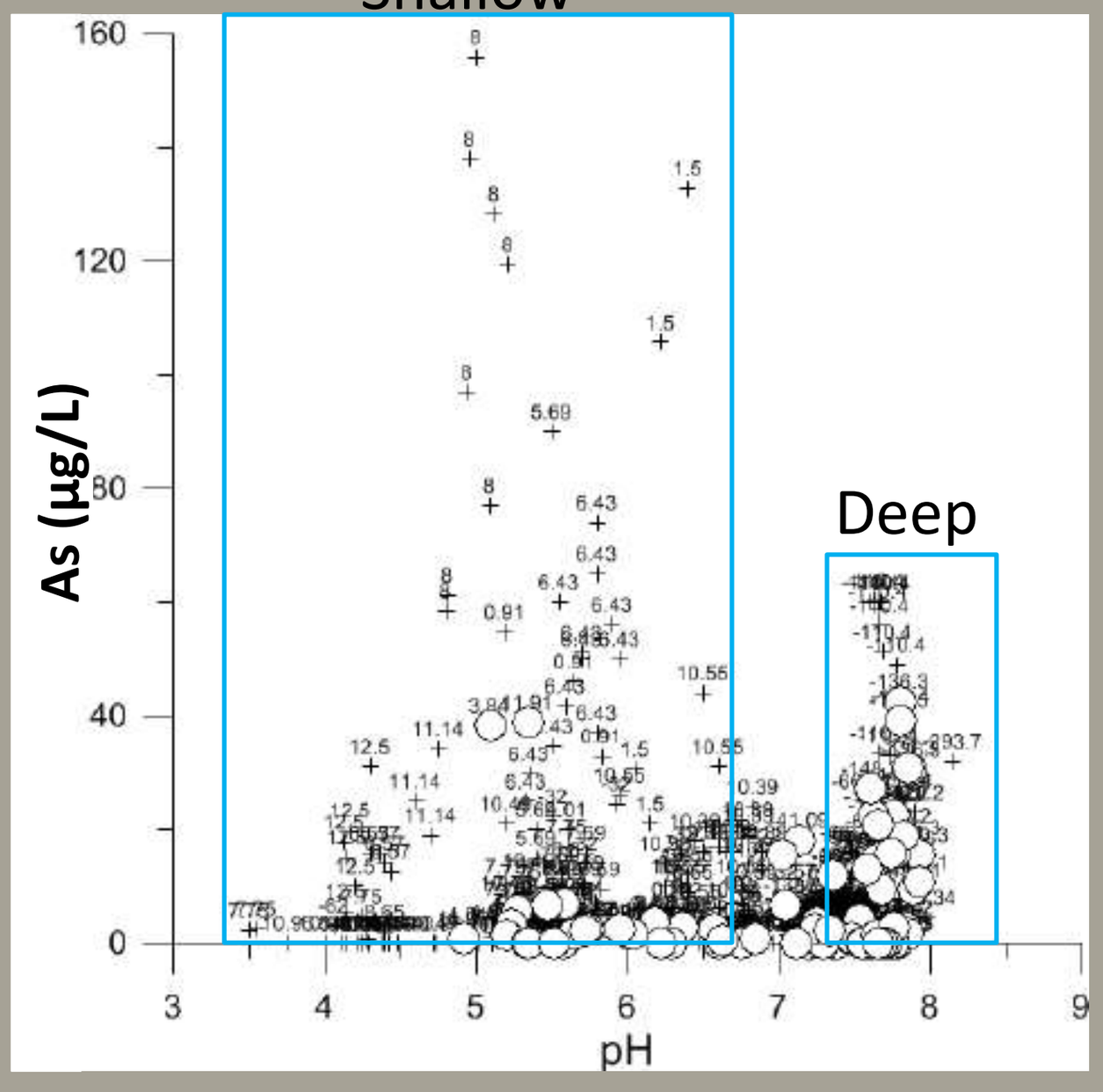
As and Fe versus pH in groundwater





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- **Historical data**
- **6 monitoring wells placed in 2016 (175 m with 10 screens)**
- **Sediment samples (x9)**

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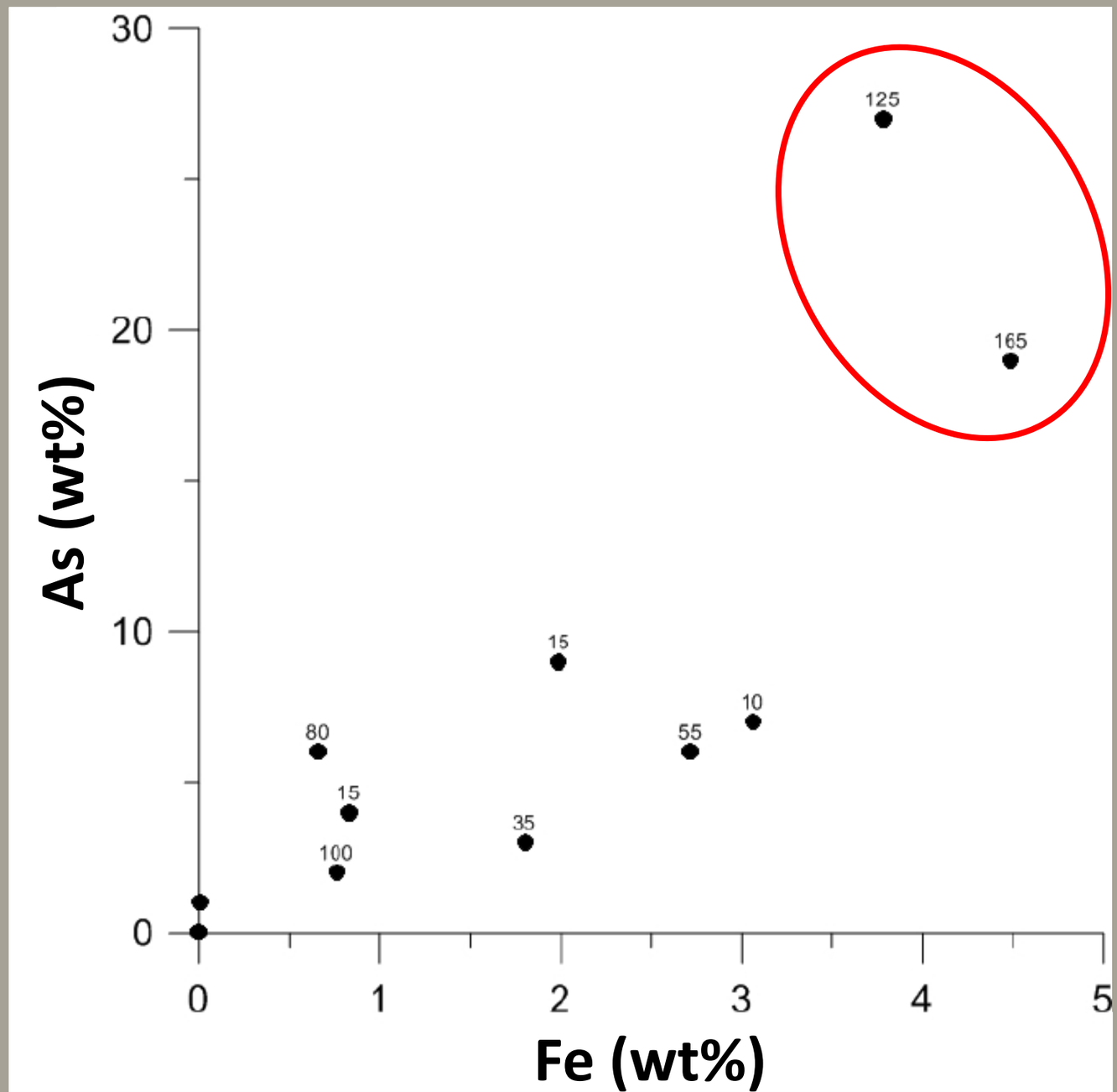
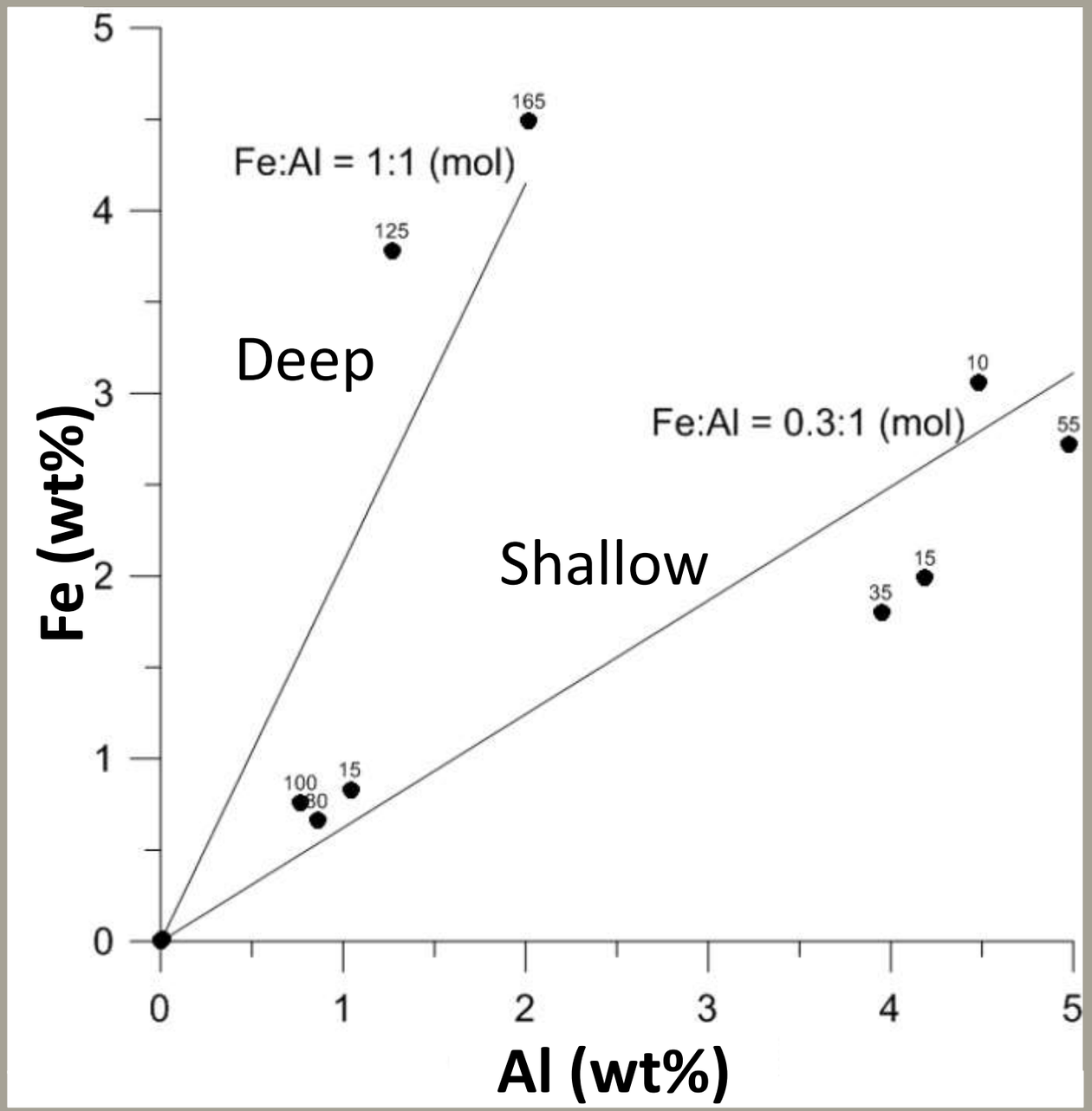
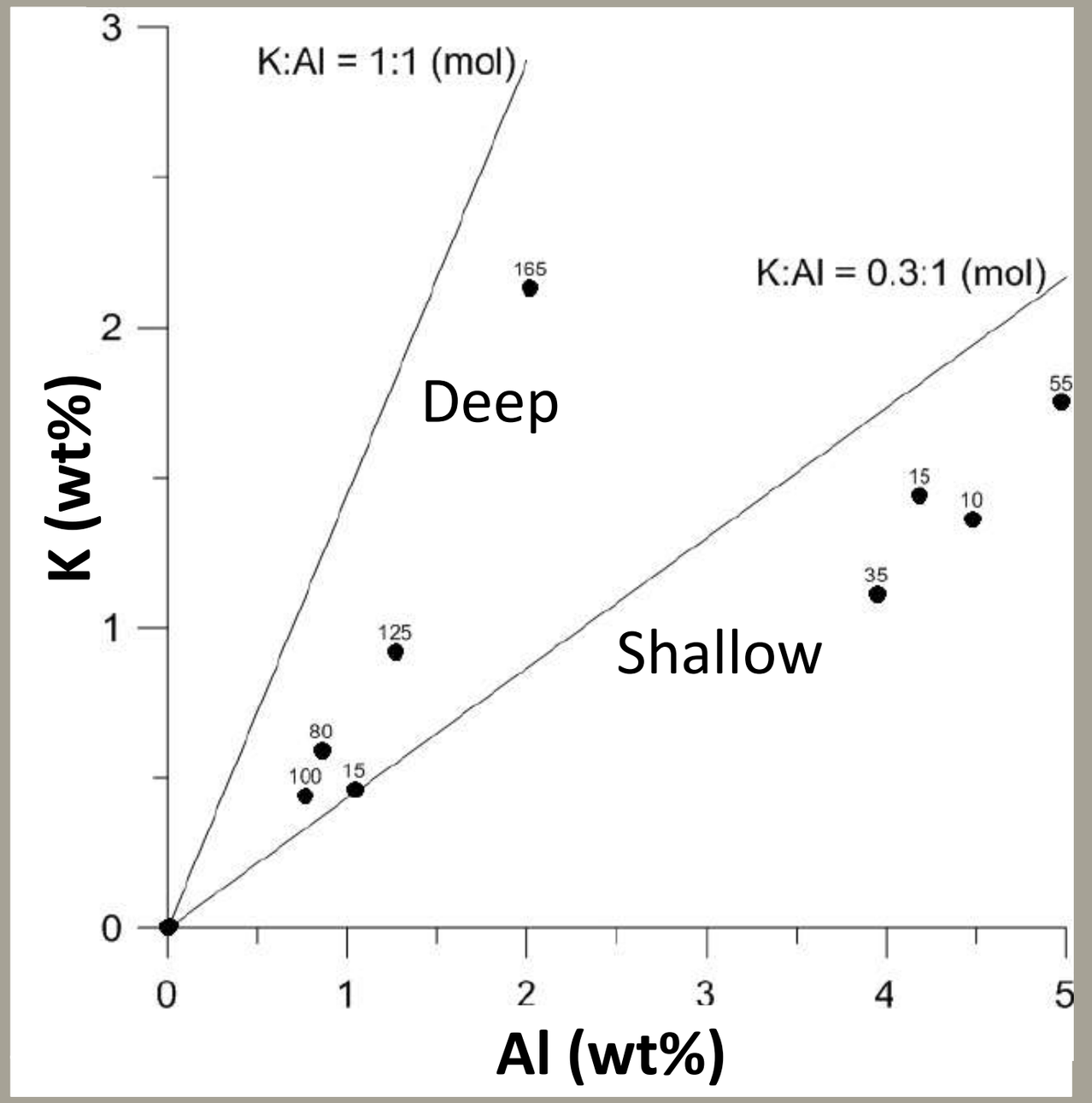
As & Fe show good correlation in deep sediment



Different ratios of Fe:Al and K:Al in sediment





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Glauconite weathering?

- Clay mineral
- Rich in K and Fe
- Formed in shallow marine conditions

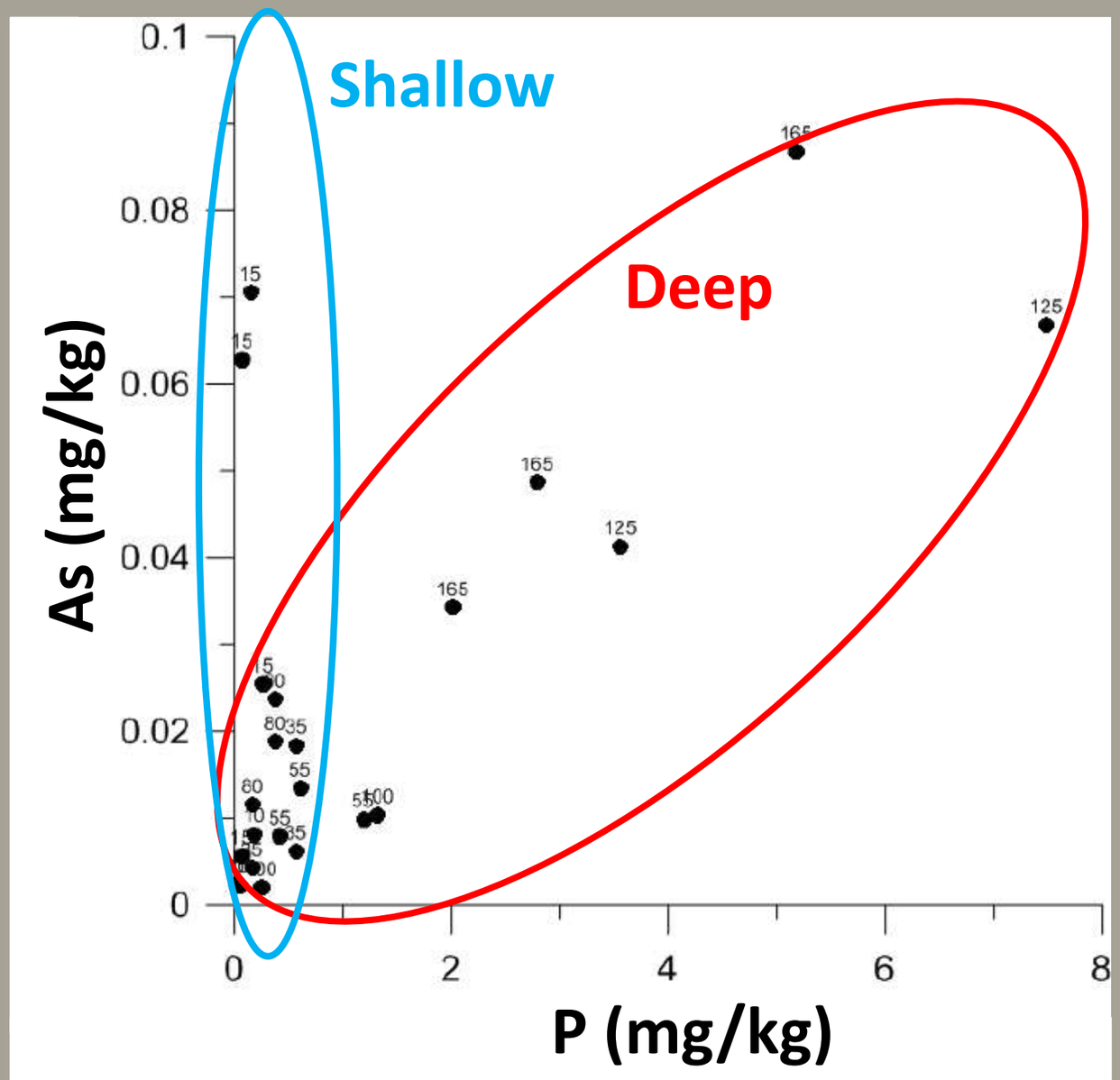
$$KFe_3AlSi_3O_{10}(OH)_2 + 3CO_2 + 6H_2O + H^+ \rightarrow K^+ + 3H_4SiO_4 + 3FeCO_3 + Al(OH)_3$$

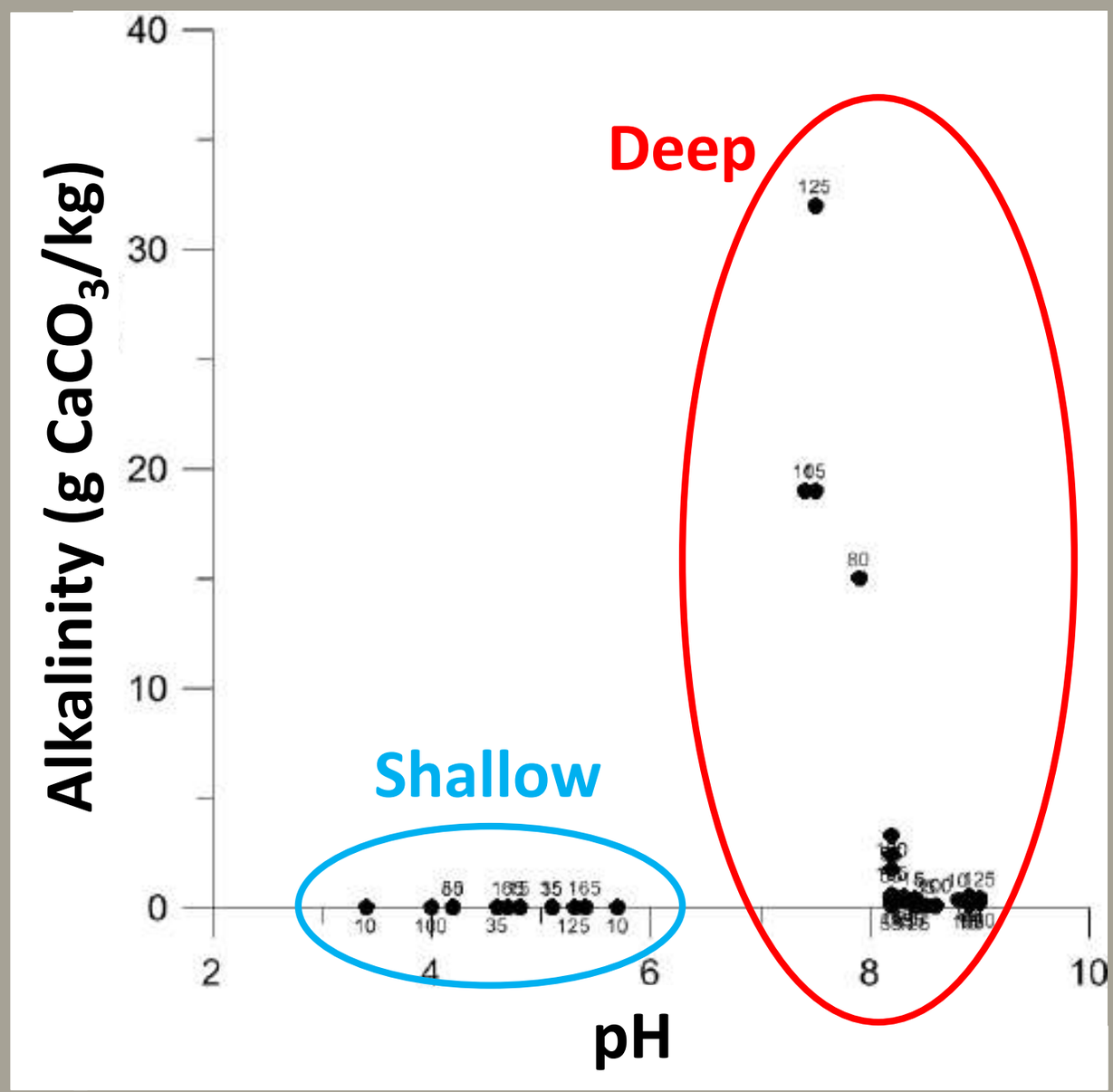
- Impurities: As (+Ti, Ca, P)

Sediment-experiments

- Sediment + demiwater + O_2 in Schott bottles
- Aerated for 2 weeks
- 3 samples of water → filtration → ICP-MS/ICP-OES
- Change of composition with time

Glauconite weathering in sediment-experiments





Impact on drinking water production

14,7 Mm^3/year with **40** µg/L As
1 m^3 sediment with **48** gram As = **1215** m^3 groudwater flushing
25 Mm^2 = protection zone, **100** m = aquifer thickness

200 000 years for complete glauconite weathering!

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Don’t flee too soon!

- Retardation of As + trace metals

→ no threat to shallow wells (~60 m)

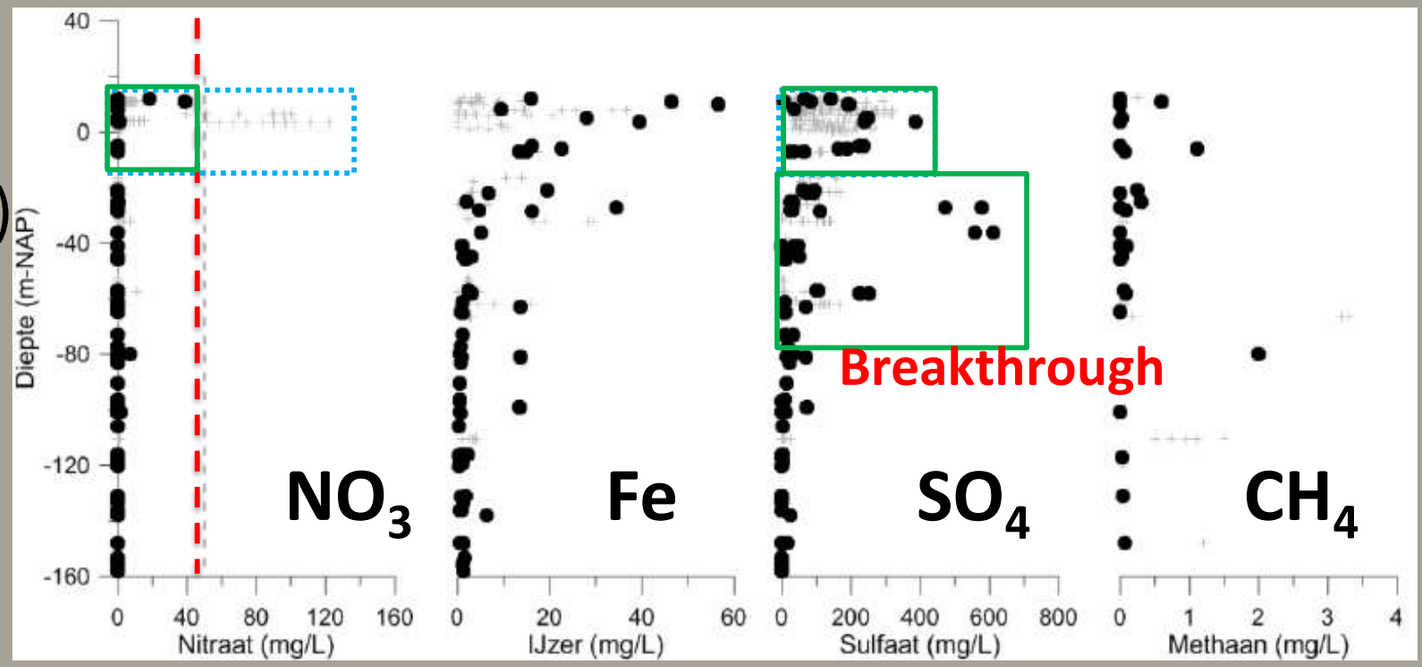
- Reduced NO_3-loading

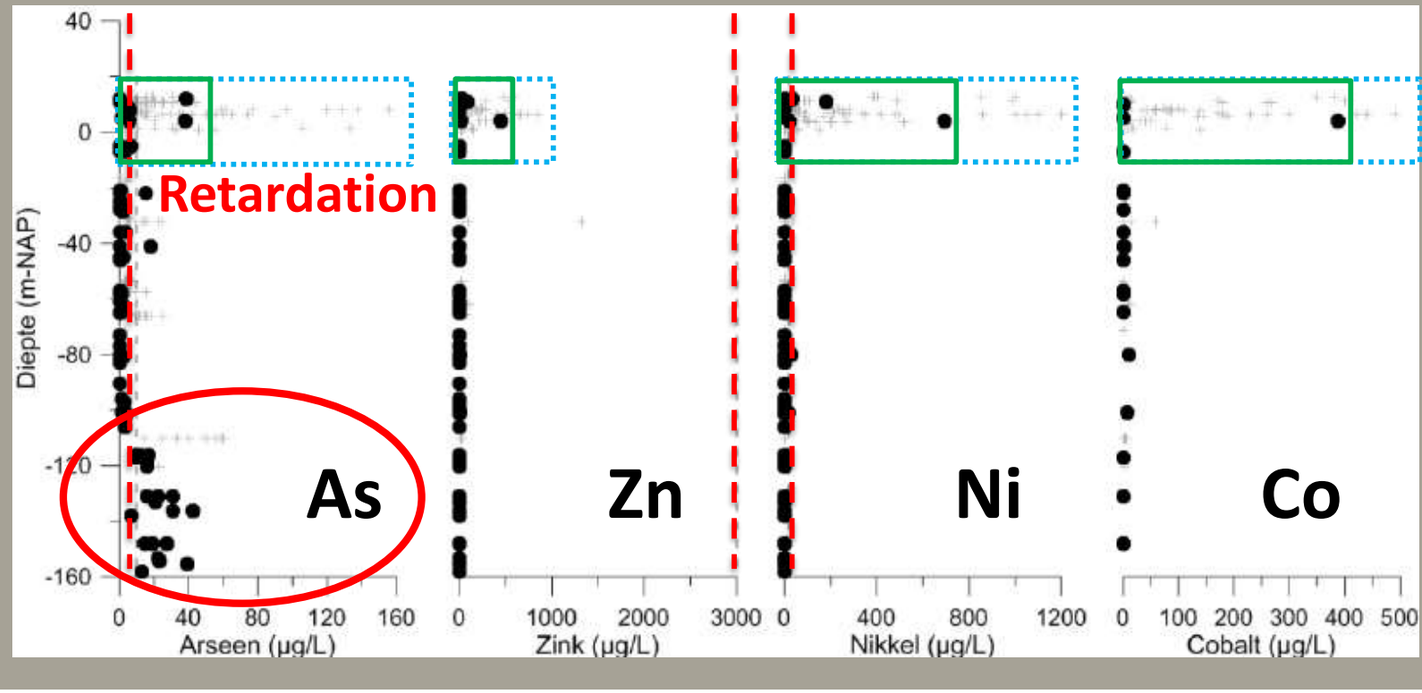
- As from geogenic sources

→ threat to deep wells (~120 m)

→ **Accept shallow SO_4 contamination?**

→ **Looking for solutions to deal with deep As contamination**





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More information?

teun.van.dooren@kwrwater.nl
www.kwrwater.nl

KWR Bridging Science to Practice

- **Van Loon, Arnaut** **Session 6:** **Tue 10:50-12:35**
  Groundwater Protection: Concepts and Strategies For Securing Drinking Water Resources In A Changing and Uncertain World

- **Hartog. Niels** **Session 2c:** **Tue 14:40-16:10**
  Prospective Shale Formations In The Netherlands: A Geochemical Assessment of Their Potential Impact On Water Quality

- **Van Dooren, Teun** **Session 2b:** **Tue 16:40-18:10**
  Geogenic Arsenic Mobilisation To Groundwater From Glauconitic Sand Formations: Geologic Origin, Geochemical Controls and Possible Solutions For Drinking Water Production

References

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